System Wide Information Management

Prototyping Activities

An Architecture for Common Messaging

Paul Comitz - Boeing Phantom Works
Josh Hung - FAA

SWIM Prototype Overview

- Context: GCNSS Program Overview
- SWIM Prototype Vision and Strategy
- SWIM Prototype Architectural Evolution
- Messaging and Data Architecture
- Security
- Summary

GCNSS Program Overview

- **Technology Development**
  - **Director of Technology Development – Wilson Felder**
  - **Data and Communication Systems – John Loynes**
- **FAA GCNSS Program Manager: John Loynes**
  - **ATO-P Data and Communication Systems**
- **GCNSS I**
  - **PoP July 2002 – August 2004**
  - **Boeing Team/FAA ATO-P**
- **GCNSS II**
  - **SWIM**
    - **PoP Sep 2004 – Aug 2005**
  - **NEO Security Demonstration**
    - **PoP Dec 04 – Oct 05**

GCNSS II Partners

Boeing Technology | Phantom Works

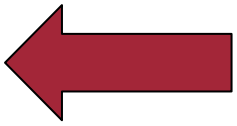
GCNSS Phase II

GCNSS II -- Overview

- **Focus on System Wide Information Management (SWIM)**

- **Systems Engineering IPT**
  - **Architecture Development**
  - **Requirements Development**
  - **Concept of Use**
  - **Transition Planning**
  - **Security Plan**
  - **Investment Analysis**

- **Demonstrations IPT**
  - **Testbed Development**
  - **SWIM Prototype Development**
  - **SWIM Demonstrations**



Today's Briefing

GCNSS Demonstration Evolution

Segment A

Jan/Feb '03

- **Security**
- **Broadband Satcom**
- **Real-time video**
- **PDA comms**

Segment B

Nov '03

Gulf of Mexico

- **Satcom simulated ATC**
- **Voice**
- **Datalink**
- **Surveillance**

Segment C

Feb '04

- **SDN**
- **Multi-Sensor Tracker**
- **3-nm enroute spacing**
- **TIS-B**

CASP Demo

CASP

SWIM Testbed

- **SDN**
- **Common Air Surveillance Picture**

SWIM Prototype

SWIM

- **SDN**
- **AIM**
- **Weather**
- **Flight Planning**

Systems Engineering – Operations & Benefits Analysis

Proof of Concept Demos and Testbed → ***Prototype***

FUTURE: Headed Toward Implementation

What is SWIM?

SWIM is a scalable, standards-based information sharing architecture that seamlessly and securely connects NAS users with the information they need.

SWIM accomplishes this by providing policies, standards, infrastructure and tools that enable NAS-wide information sharing.

SWIM provides the NAS capability for securely accessing the right information in the right format at the right time at the right location.

SWIM Prototype Vision – Interoperability

- **Vision Statement:**
  - **Provide an example of a system that organizes information by routing messages between network interfaces**
    - **Messages provide access to data, logic and infrastructure**
- **Design Pillars**
  - **General purpose messaging language**
  - **Platform-independent message encoding**
  - **Service lookup and discoverability**
  - **Interfaces described by standards-compliant contracts**
  - **Data architecture based on existing work where possible**
    - **e.g. FDR/AICM/NSDI**

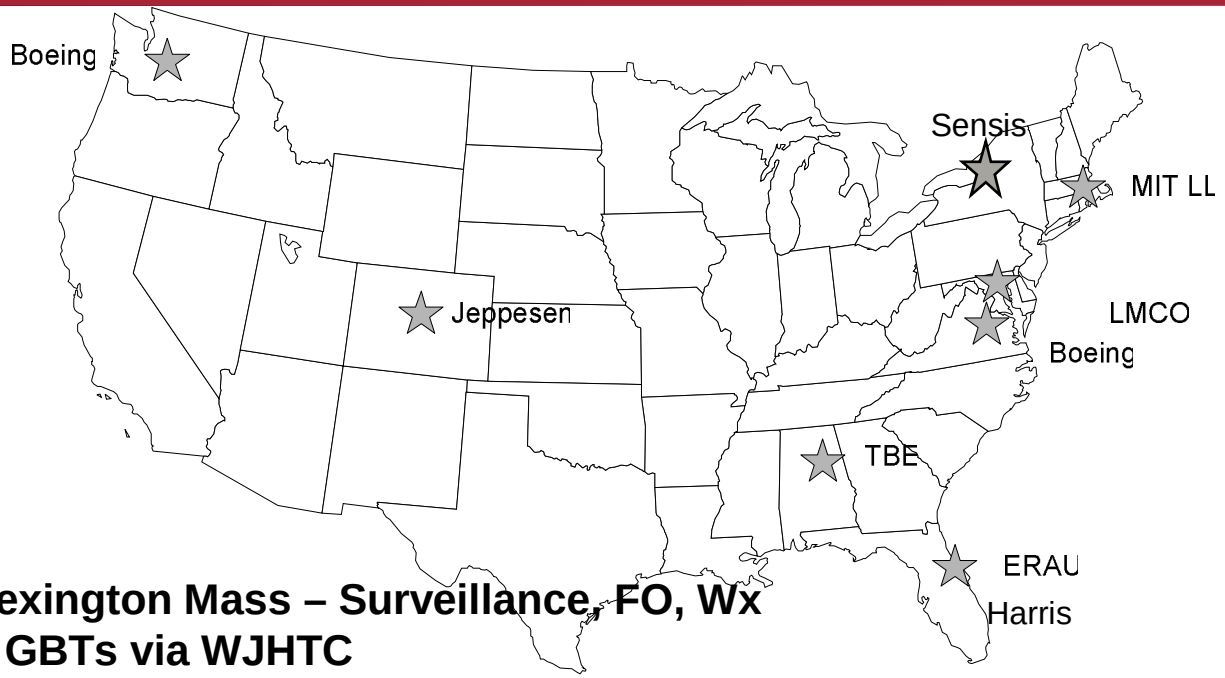
All applications shall integrate

SWIM Prototype Strategy

- **Demonstrate the use of data distribution and access techniques in as many FAA and government systems as possible**
  - **FAA UDDI Enterprise Taxonomy (I-1)**
  - **FDR/AIXM METARS Service using NIXL (II-4)**
  - **SWIM Surveillance Service distribution to NAS HOST/DSR (II-5/6)**
  - **Virtual Radar Service to NAS Host (III-2)**
  - **WARP Distribution Service (IV- 3)**
  - **NAIMES Distribution Service (IV-4)**
  - **EAS/SWIM Test bed Track Mediation**
  - **ASDE-X**

Provide value NOW by working with existing programs

SWIM Distributed Testbed

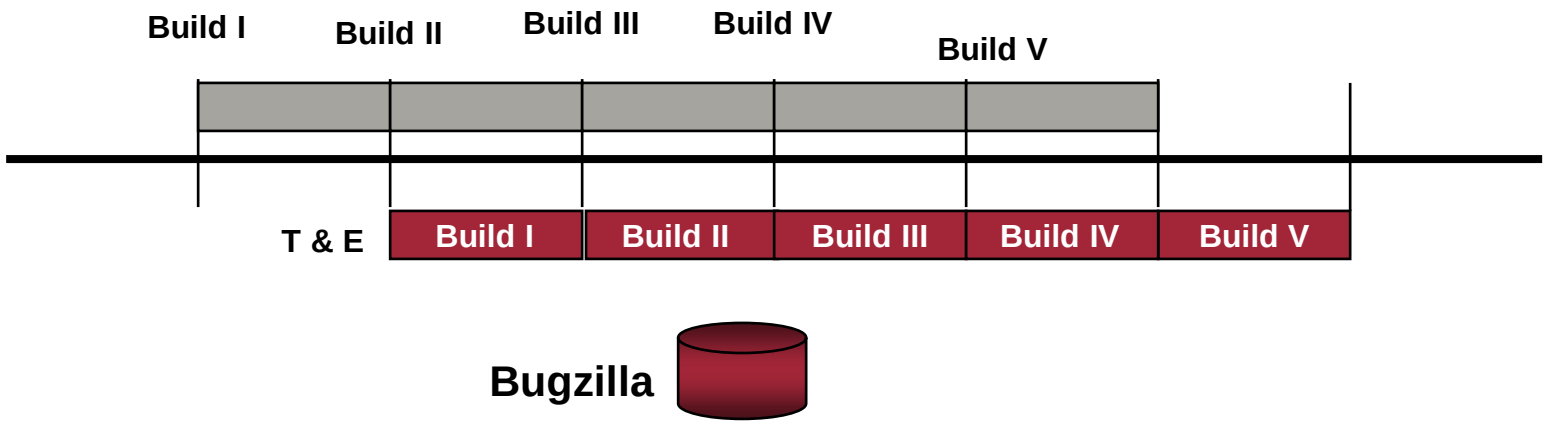


- **MIT LL , Lexington Mass – Surveillance, FO, Wx**
  - **ADS GBTs via WJHTC**
- **Lockheed Martin, Rockville, Md. – ATM Lab**
- **Boeing PW, Herndon Va. - SWIM Laboratory**
- **ERAU, Daytona Beach, Fl. - Air Traffic Displays**
- **Teledyne Brown, Huntsville, Al. (vpn) - AAFAS**
- **Jeppesen, Denver, Co. – AIM**
- **Boeing PW, Kent, Wa. SWIM Laboratory**
- **Harris – WARP**
- **Sensis, Syracuse, NY – MST, SPM**
- **Raytheon – STARS ***
- **CSC - React ***

*Raytheon and CSC currently being added as p/o NEO Security Demo

SWIM Prototype

- **Strategy**
  - **Small Frequent Builds**
  - **Wide and thin**
  - **4 spirals plus reserve**
    - **Build I in lab Jan 31**
    - **Build II In lab Feb 28**
    - **Build III in lab April 14**
    - **Build IV in lab May 15**
    - **Build V in Lab June 30 (reserve and demo support)**
- **Test periods follow builds**
  - **Record test results in Bugzilla**



SWIM Prototype Initial Build Plan

Functional ID	Capability
	Jan 2005
I-1	UDDI Registry
I-2	Populate UDDI with CIWS/RAPT Contour
I-3	Populate UDDI
I-4	Manually populate UDDI with Surveillance Republishing
I-5	Dynamic Discovery of CIWS/RAPT Contour Service
I-6	Initial Integration of Contours
	Feb 2005
II-2	Surveillance Republishing Web Service
II-4	METAR/NexRad Web Service
II-5/6	Host/DSR information migration I
II-8	Flight Objects I

Provide an infrastructure for service discovery

Populate testbed with initial services

Initial information migration

Prototype Status and Build Plan

Functional ID	Capability
	Mar 14 – April 14 2005
II-3	CIWS Echo Tops
III-2	Host/DSR Virtual Radar Service
III-3	Flight Objects II
III-5	MSFS Maintenance
III-7	Surveillance Performance Monitor
	April 15 – May 15 2005
IV-1	Flight Data to Host
IV-2	NIXL AIM Web Service
IV-3	WARP Products Web Service
IV-5	Jeppesen TFR Web Service
IV-6	FO Republish Web Service
IV-7	AAFAS Web Service
IV-8	Identity Management
IV-9	XML Schema Registry
IV-10	Surveillance Performance Monitor Web Service

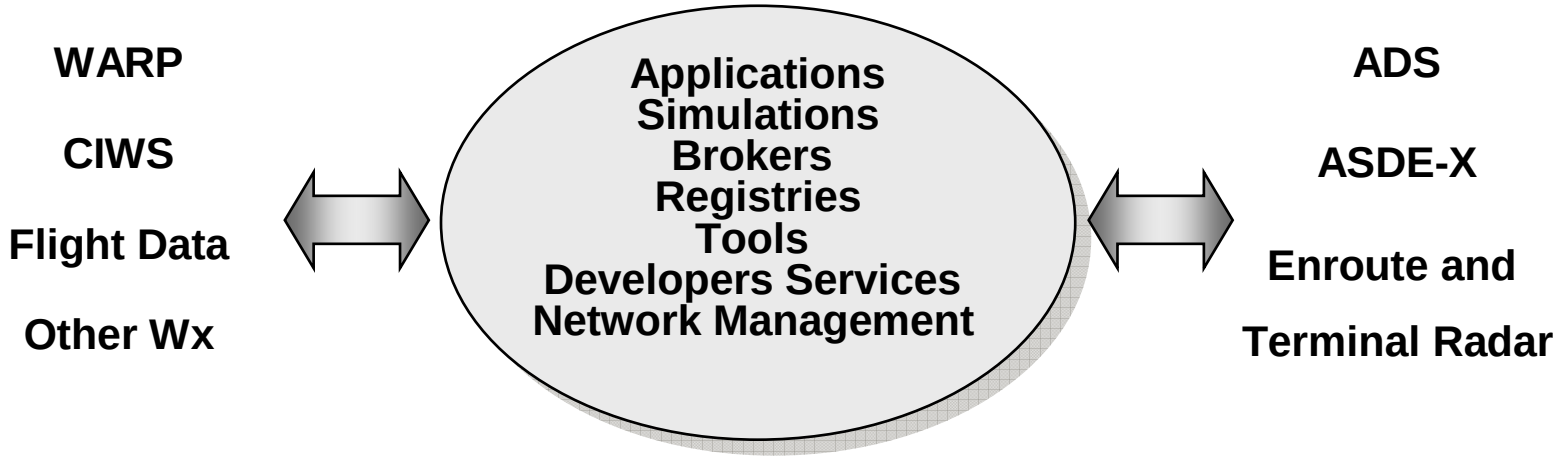
Additional Surveillance and Flight services

Continue Service deployment

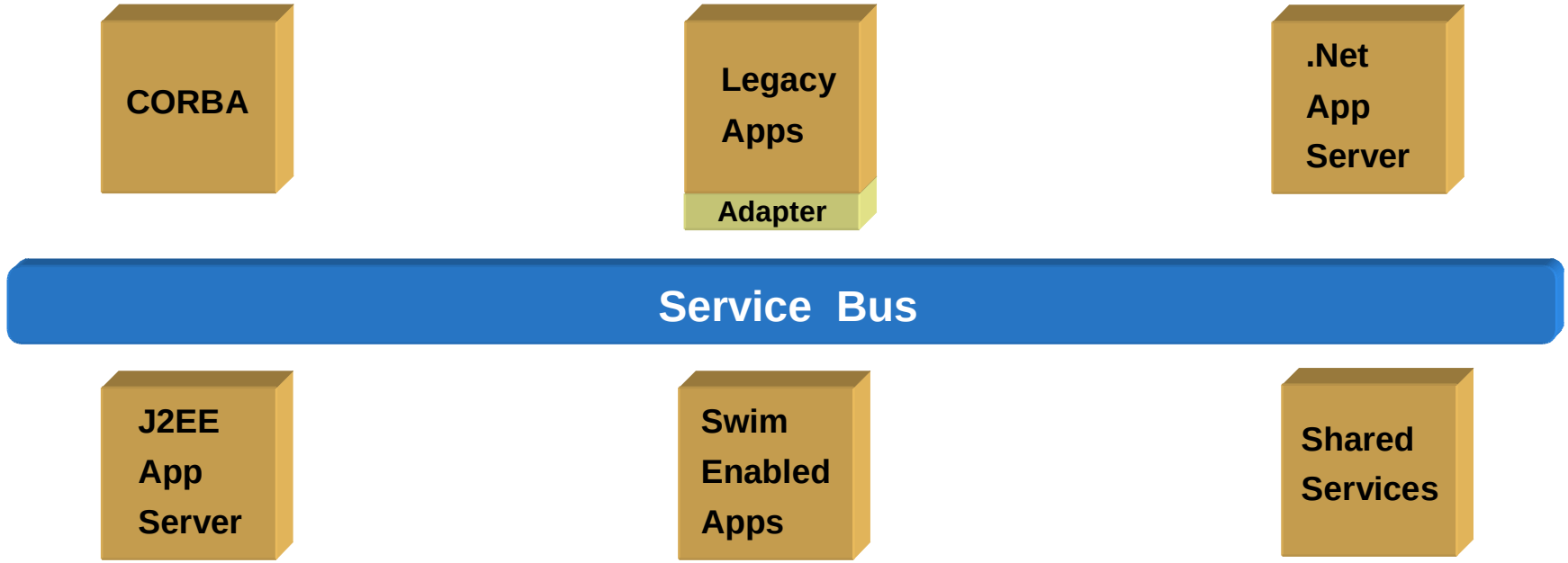
Transition to demo support

SWIM Prototype and Test Bed
Near Term Benefits

- **Representative SWIM Environment**
  - **Demonstrative Surveillance, Wx, and AIM services**
  - **Possible to evolve to additional services, agency integrations, and environments**
- **Benefits**
  - **Engineering Experiments and Evaluations**
  - **Rapid prototyping environment**
  - **Evaluations of anticipated products and services**
  - **Inter-agency Integration platform**

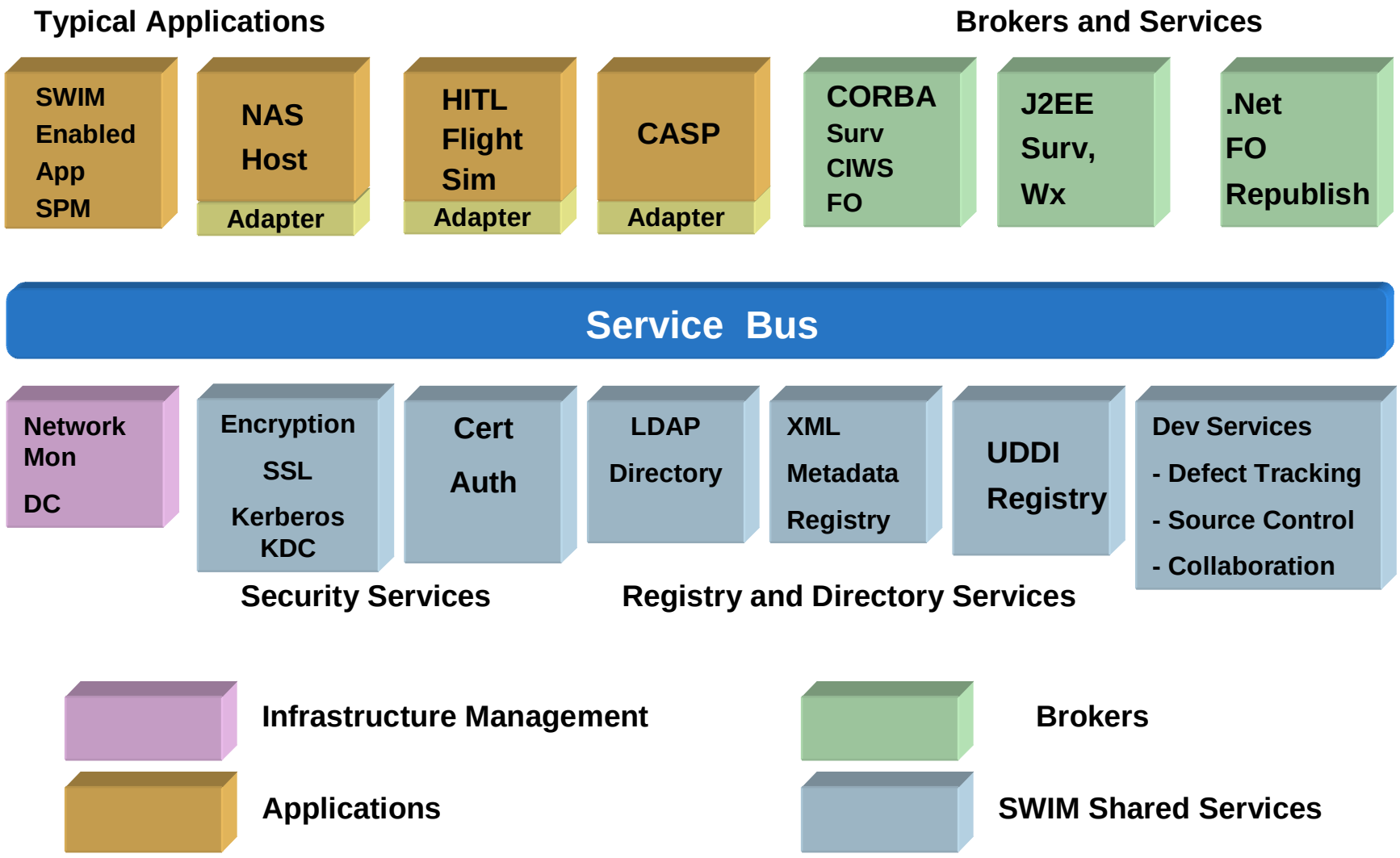


Initial View Prototype Architecture
Conceptual Simplicity Promotes Interoperability

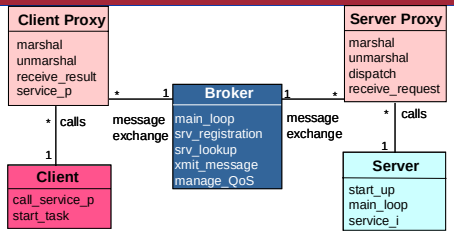


- General purpose messaging language – NIXL
- Platform-independent message encoding – XML Schemas and CORBA Objects
  - Use COTS Application Servers
    - J2EE and .Net
  - CORBA
- Service Lookup and Discoverability – UDDI, XML Registries
- Standards Compliant Contracts – WSDL

Prototype Architectural Evolution
Build II Snapshot

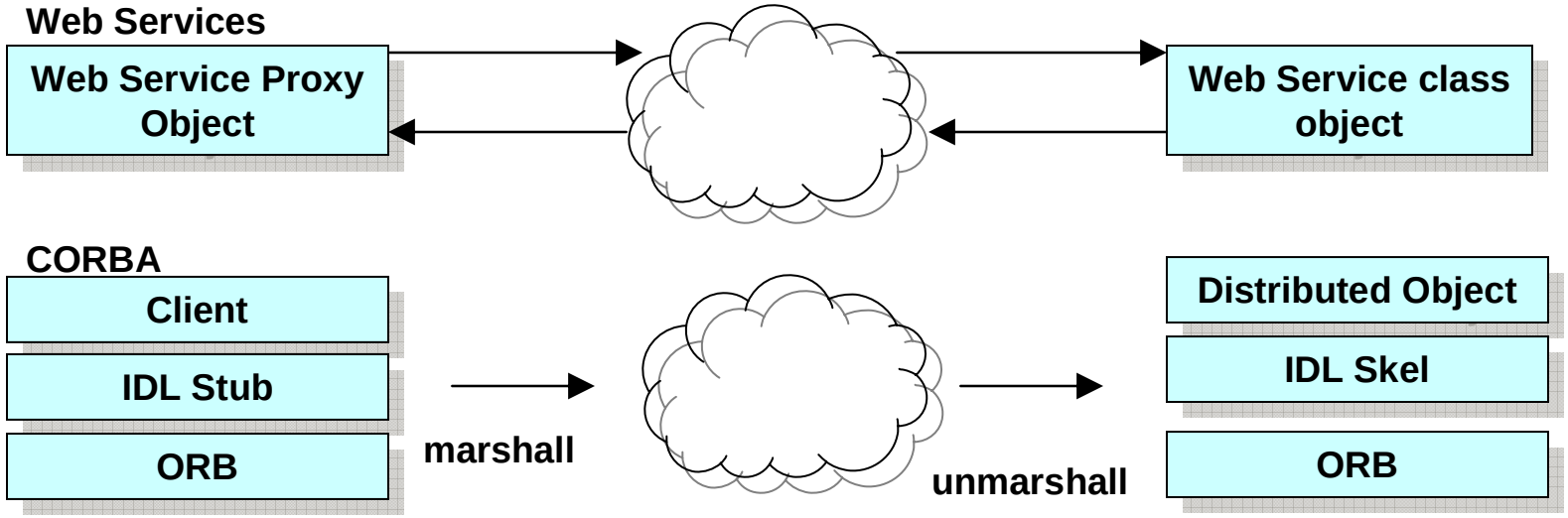


SWIM Broker Services



Initial Arch View (from SWIMAD)

1. Discover Service in Registry
2. Service Contract defines exposed functionality
3. Invoke exposed function Serialize and pass parameters
4. Web Service receive via http-post, http-get, http-soap
5. Process and return results (if any)



- **Web Services**
  - Enormous industry momentum
  - Simpler, reduced infrastructure
  - Cross platform
  - Zero install clients

SWIM Protyotype

- **CORBA**
  - More infrastructure
  - More powerful and flexible
  - Also cross platform
  - Segment C : 1100 tracks distributed using commodity platforms

SWIM Common Messaging and Data Architecture

- **Prototype Design Pillars**
  - **General purpose messaging language**
  - **Platform-independent message encoding**

- **Based on NIXL: NAS XML Language**
  - **Application-to-application and System-to-system communication depends on Common Messaging standard (NAS XML language)**
    - **Josh Hung FAA ATO-P System Engineering**

- **Guidelines**
  - **Address overlap and duplication**
  - **Application and environment neutral**
  - **Expandable**
  - **Leverage existing data models**
  - **Compose messages from smaller elements**
    - **Lego pieces**
  - **Use Features and Data Types subschema**
  - **Candidate Namespaces**
    - **weather, surveillance, aim, nims, flight**

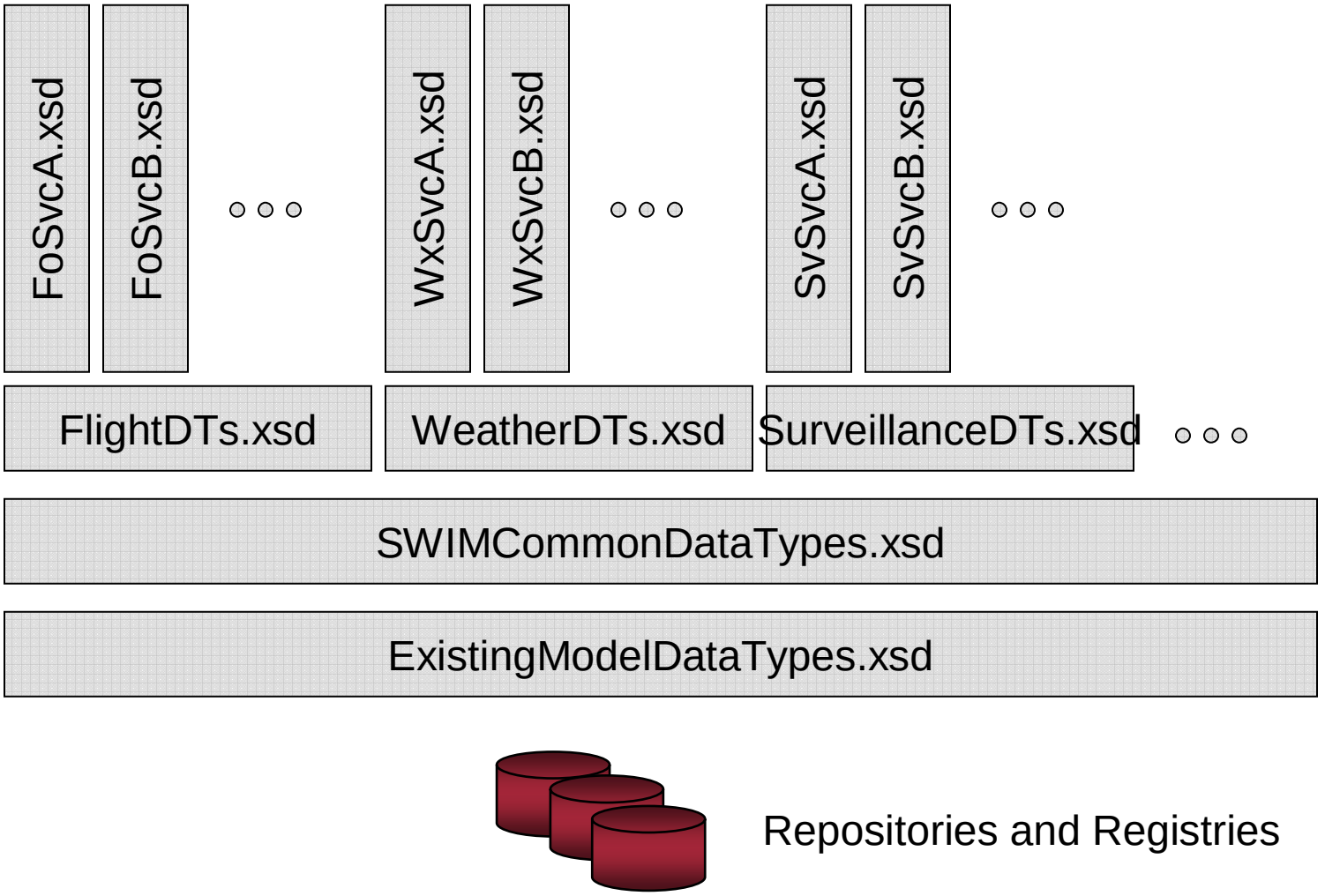
Use SWIM Prototype as Test bed for Common Messaging

Schema	Description
LMATM_CSA_primitives.xsd	Position, time, speed, identifications
LMATM_CSA_flight_plan.xsd	Flight plan, modifier, filed route
FlightMessage.xsd	Conversion of CORBA IDL
METAR-Message.xsd	METAR for KIAD, KJFK etc.
Weather-Types.xsd	Wx type for METARS message
SDN.xsd	SDN V2 message and data types
SDN-DataTypes.xsd	SDN V2 data types
SDN-Feature.XSD	Track, Track Drop, Beacon Plot,
SML.xsd	SML message using SML features
SML-DataTypes.xsd	time, mode codes, positions
SML-Features.xsd	Sensor types, track types, plot types
AAFAS.xsd	AAFAS alert message
AAFAS-Features.xsd	Flight Info, Flight params, Location, Resources
AAFAS-DataTypes.xsd	Alerts, positions,
SPM Radar Assets.xsd	Health Status of NAS Surveillance Assets
Cat62p9ed12v0.1.xsd	Asterix Category 62 Part 9 version 1.2

Tiered Schema Files

- **Each of the N systems in the NAS, left to it's own devices, would propose it's own 'preferred' schema, tailored to it's own needs and capabilities.**
- **To avoid such a 'schema explosion' NIXL schemas should be built using a tiered data model**
  - **The lowest-level schemas containing the most primitive, most widely applicable data types.**
  - **The next containing domain-specific data types.**
  - **The next containing interest-specific data types.**
  - **The top most containing service-specific data types.**
- **When proposing new NIXL elements, the designer must**
  - **First, make every attempt to use existing elements and data types**
  - **If no existing element/data type meets the need, propose a new one, designed to the tiered model**

Tiered Schema Files



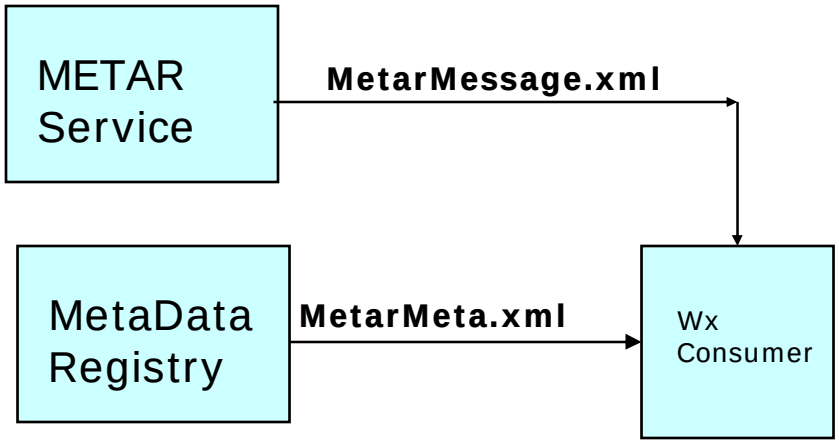
Lemma : Avoid Conversions

- **Scientific data are typically conveyed using**
  - **magnitude**
  - **units of measure.**
- **Interoperating systems may use different units of measure**
  - **Meters per second**
  - **Kilometers per hour**
  - **Cubits per fortnight, etc….**
- **Data supplied by system A must be converted by system B to B's units of choice**
  - **May lead to spectacular system failures:**
    - **Mars Climate Orbiter ***
    - **Ariane 5**
- **Can lead to N^2 cost as each of N systems must implement and test conversion routines for the N-1 different units of measure it receives.**
- **To avoid conversion errors and to reduce cost, NIXL primitive data types should have a single, implicit, domain-common (or otherwise), unit of measure.**
  - **Altitude values, traditionally measured as "Feet Above MSL", should be based on a primitive type named "FeetMSL" for example**
  - **Range values should be based on a primitive type named "NauticalMiles"**
  - **Velocity values should be based on a primitive type named "Knots"**
  - **etc…**

The 'root cause' of the loss of the spacecraft was the failed translation of English units into metric units in a segment of ground-based, navigation-related mission software, as NASA has previously announced

MetaData Schemas

- **Potential Approaches**
  - **Message by Message**
    - **METAR-Meta.xsd**
    - **Field by field definition of METAR-Message etc.**
  - **All domain**
    - **i.e. Weather-Meta.xsd**
    - **Definitions of all data elements in classification scheme**



Prototype Security

- Messaging
  - Authenticity
    - Confirm the senders identity
      - Attach security credentials to message
        - Passwords
        - Security tokens
        - Digital certificates X.509
  - Integrity
    - Ensure that a message has not been altered
  - Confidentiality
    - Keep the contents confidential
      - Encryption

Summary

- **SWIM Prototype features:**
  - **Multiple technologies and computing environments**
  - **Multiple Services**
  - **Distributed Test Bed**
  - **Live Enroute, Terminal, and ADS**
  - **Live Weather**
  - **Live AIM**
- **Common Messaging**
  - **A grammar for aeronautical applications**
  - **Evolving**
  - **Requires a patient, but steady approach**